Optical energy band gap of the conductive $AgGaSe_2$ layers

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Abstract : The photoconductive $AgGaSe_2$ (AGS) layers were grown by the hot wall epitaxy method. The AGS layer was confirmed to be the epitaxially grown layer along the <112> direction onto the GaAs (100) substrate. The band-gap variation as a function of temperature on AGS was well fitted by $E_g(T) = 1.9501 - 8.37 \times 10^{-4}T^2/(T + 224)$. The band-gap energy of AGS obtained at 293 K was determined to be 1.8111 eV.

Key Words : photoconductive $AgGaSe_2$ (AGS) layers, valence band state, optical absorption, band-gap energy

1. Introduction

Silver gallium diselenide ($AgGaSe_2$, AGS), which crystallizes to the chalcopyrite structure [1], has received considerable attention in recent years because of its high optical absorption.

The photoconductive AGS layers were grown using the hot wall epitaxy (HWE) method. Thus, the grown AGS layers were investigated by optical absorption.

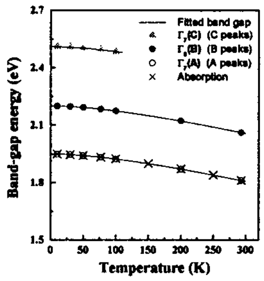

Fig. 1 Band-gap variation as a function of temperature on AGS obtained from PC and absorption measurements

2. Results and discussion

Figure 1. shows the optical absorption spectra obtained in a temperature range of 10 to 293 K.

The band-gap variation as a function of temperature can be well fitted numerically by the following formula [1]:

$$E_g(T) = E_g(0) - aT^2/(T + b), \qquad (1)$$

where a is a constant and b is approximately the Debye temperature. $E_g(0)$ is the band-gap energy at 0 K. When a and b are set at 8.37×10^{-4} eV/K and 224 K, respectively, the curve plotted in (1) closely fits the experimental values.

3. Conclusion

The photoconductive AGS layers were grown by the HWE method. From the results of the XRD measurement, the optimum growth temperatures of the substrate and the source turned out to be 420 and 630 °C, respectively. The band-gap variation as a function of temperature on AGS for the equation: $E_g(T) = E_g(0) - 8.37 \times 10^{-4}T^2/(T + 224)$. Also, $E_g(0)$ was 1.9501, 2.2001, and 2.5104 eV at the valence band states of $\Gamma_7(A)$, $\Gamma_6(B)$, and $\Gamma_7(C)$, respectively; also the band-gap energy of AGS obtained at 293 K was 1.8111 eV through the PC experiment and optical absorption.

References

1. H. Matsuo, K. Yoshino, T. Ikari, Phys. Stat. Sol. (c) **3**, 2639 (2006)